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The MONTHLY REVIEW

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American Electro-Platers' Society

A SOCIETY FOR THE ADVANCEMENT OF THE SCIENCE OF ELECTRO-PLATING

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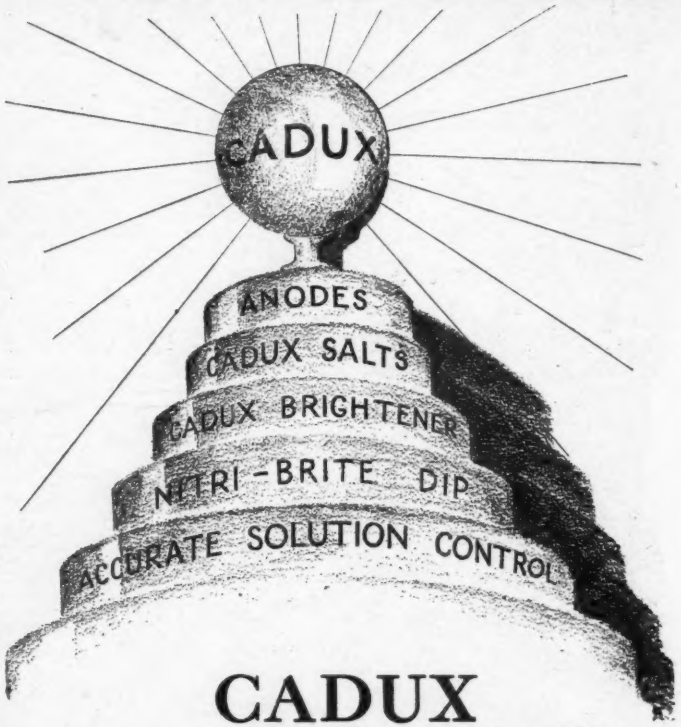

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The MONTHLY REVIEW

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American Electro-Platers' Society

Convention and Exhibition

June 10 - 13, 1935

Bridgeport, Conn.

Convention Notes

FORTUNATELY the Master Electro-Platers are holding their national Convention in Bridgeport June 8th and 9th, and there is no doubt that many of them will stay over to take in the convention and exhibition of the American Electro-Platers' Society.

On Plant Visitation Day, permission has been granted to visit two very interesting plants—namely, the American Tube & Stamping Plant of the Stanley Works, and the Bridgeport Brass Company—the former being a steel plant and the other brass. Visitors will have their choice as to which of the above plants they wish to visit during the morning. Both are in Bridgeport.

American Tube & Stamping Plant: The American Tube & Stamping Company was purchased by the Stanley Works in 1926, and since that date an extensive program has been carried out to give New England a modern steel plant. The consolidation of these two concerns, who established the Cold Rolled Steel Industry, was a major step in this direction. As generally understood, Cold Rolled Strip Steel in this country was pioneered by the Stanley Works in 1871, but the American Tube & Stamping Company started in this field soon after. Hot Rolled Strip Steel is now the principal steel made at the Bridgeport plant, along with Billets and Cold Rolled Strip. With its extensive waterfront, barges of scrap, pig iron, coal and oil are a main source of supply for the principal raw materials necessary for

three open hearth furnaces, one of 100-ton and two of 50-ton capacity. A 34″ Blooming Mill and six-stand 22″ Billet Mill comprise the set-up for semi-finished products, slabs, bars, and billets. Two Hot Strip Mills, with a range from 1″ to 12-5/8″ are modern semi-continuous Mills. Finishing, Pickling, and Auxiliary Departments complete the Hot Rolled picture. These mills supply Hot Rolled Strip for the Howard Avenue Cold Rolling Mill at Bridgeport, and the Stanley Works Cold Rolling Plant at New Britain—in addition to the trade.

Bridgeport Brass Company: The Bridgeport Brass Company is one of the largest independent brass and copper mills in the United States. During its 69 years of steady growth, it has pioneered in developing and perfecting a constantly higher quality of brass and copper products. Established in 1865 by a group of men long experienced in the brass business, the Bridgeport Brass Company has steadily grown until it is now one of the largest and most complete independent brass mills in America. In the many years of its existence, it has steadily maintained a position of leadership in modernizing brass craftsmanship. It pioneered the greatest innovation in the brass industry—namely, the replacing of all of its crucible fires with electric melting furnaces which it had previously helped to develop. It has also made many improvements in the brass mill practice of processing of rod, sheet, wire, pipe, and tubing, all of which have been accepted as standard practice. This company has been making seamless copper and brass tubing and pipe for over fifty years. Its brass pipe ("Plumrite") is found in many of the finest and most important buildings and homes throughout the country. Its facilities for making copper tubing are most modern, assuring a product of utmost dependability.

Exhibition: More than 50% of reservations have been contracted for by exhibitors. Many others have made reservations for booths, but until the contracts are definitely signed, they cannot be counted as in the show.

The exhibit will be held in a building entirely apart from the hotel and very well adapted to exhibitions of this kind, being about five minutes' ride from the hotel. Continuous bus service will be maintained from the hotel to the exhibition hall.

Many of the exhibitors are going to give a working demon-

stration of their products such as plating with galvanizing, removing scale, oxide, etc.

It will be to the mutual advantage of all concerned for the management of all eastern industries to make suitable arrangements for the key men of their organizations to visit the Exhibition and learn new ways and methods to produce better work and to see the latest equipment with every modern improvement.

To Potential Exhibitors!

In a recent issue of the "New England Furchaser" one of its members asked the following question:

"*How best can I sell my products?*"

The following answers were given:

First, by advertising. Second, by direct contacts through the medium of salesmen. Third and most impressive, by exhibiting your products.

We know of numerous concerns who desire to exhibit their products, but to date have not taken space, and for the benefit of those who have already contracted for space and those who we expect to later on, may we give you an indication of the type of an audience you will find during the five days of the Exhibition.

It is conservatively estimated that 20,000 to 30,000 men directly interested in plating and metal finishing materials from New York, New Jersey and the New England states will visit the Exhibition. In addition to this group, you will find the Society members who register at the annual convention consisting of from 600 to 800 men. You will also have technicians and plant executives in attendance. Nothing is being left undone to make this, the first complete Exhibition of its kind ever undertaken, a howling success.

It is going to require the co-operation of all concerns who are a part of the metal finishing industry. An exhibitor need have no fear of being unduly taxed, as we are free from labor troubles and rackets in Bridgeport.

For further details please communicate with R. T. PHIPPS, *Manager of Exposition*, 271 Grovers Ave., Bridgeport, Conn. Home Phone 3-5207, Business 5-4151

Ductility and Adhesion of Nickel Deposits

By F. P. ROMANOFF

Read at Detroit 1934 Convention

"THE application of nickel and chromium electrolytic deposits to bases of copper, brass or steel, does not ordinarily require much consideration beyond good adhesion, good appearance and corrosion resistance. When these requirements are fulfilled most, if not all, plated fabricated articles are acceptable. However, when fabrication is desirable subsequent to electroplating, new and interesting plating problems are encountered. Nickel electrodeposits, whether on sheets of steel, tinplate, copper or brass, when plated from the same solutions present similar problems. In the case of Ni Plated steel, however, unless use is made of the ferroxyl paper test or microscopic examination of deformed areas, the hardness of the Ni deposit is not always easily detected by the purchaser of pre-finished sheet which is to be fabricated. A base of copper discloses at once a hard deposit. The fractured nickel film premits the base to be seen quite readily, when the thickness of Deposit is below 0.00040 in. Above this thickness hard nickel deposits may be mildly deformed without allowing the base copper to show through. However, the base metal itself is apparently hardened considerably during the Ni plating operation and the ductility of the composite material as a whole is diminished.

"In the course of depositing nickel on sheets which were to be subsequently fabricated by drawing or forming operations, it was found desirable to obtain, if possible, a very ductile nickel deposit. After some development work, there was evolved a very ductile type of nickel. Specifications were set up by a midwestern manufacturer, requiring approximately 0.00025 in. of electro-deposited nickel, which would withstand the impression of one-inch steel ball to a depth of 0.225 in. without exposing the copper base. This ball test is in effect a modified

Ericksen cup test. The depth of extrusion referred to is standard, and was used in all tests except where extruded to fracture.

"The deposits of nickel were studied and compared with rolled nickel, as well as with the type of nickel deposit supplied by manufacturers who did their own plating on fabricated articles. Investigation is now in progress on the corrosion protection of both the ductile and hard types of nickel deposits. Determination of lustre, scratch hardness and other properties are also being investigated.

"*Slide* 1. Table 1 shows some physical properties of several types of nickel. Hardness numbers are given in both sclerescope and duroskop values in order to illustrate the adaptability of the latter instrument to hardness testing. Hardness tests of even thick nickel deposits over other bases are affected by the base metal. The hardness numbers of the deposits of nickel on copper only serve as indicators, since the softer base metal interspersed between the anvil and the deposit must have a marked cushioning effect.

"You will note in the table that the first four items are solid sheet nickel of .015 inch in thickness. These were rolled by the International Nickel Company. The regular cold rolled commercial nickel is made by rolling slabs of nickel cast from electrolytically refined cathodes.

"Annealing the ordinary cold rolled commercial nickel in hydrogen gave an extremely ductile deposit.

"Annealing of cold rolled electrolytic nickel which was rolled from the cathode nickel without remelting gave a ductility appreciably greater than that of the unannealed material, but approximately only equal to the ductility of unannealed cold rolled commercial nickel. It is to be noted that the sclerescope hardness of the annealed cold rolled electrolytic nickel is less than that of the annealed cold rolled commercial nickel, but that the electrolytic nickel is not nearly as ductile. This serves to illustrate the fact that hardness indentation tests have no absolute relation to ductility.

"The dome of the hard nickel deposit on copper fractured at a depth slightly less than that of the commercial electrolytic nickel.

"*Slide* 2. Figure 1 represents the hard deposit which we see

is of a fibrous or columnar structure. The thickness of this particular deposit is about six thousandths of an inch.

"*Slide* 3. Figure 2 represents a ductile nickel deposit which is of a conical or pyramidal structure.

"Notice the fine conical structure next to the base. Deposits of five ten thousandths inches and less show this type of structure, which at first appears to be very fine and broken.

"*Slide* 4. Figures 3A and 3B show the domes of the two different types of deposits of nickel on copper of the preceding slides at the point of fracture. 'A' represents the ductile and 'B' the hard deposits. The unplated copper base fractures at the same depth as the dome of the plated specimen shown in 'A'.

"*Slide* 5. An explanation of the difference in ductility is based on the assumption that the conical type of structure permits slippage of grains upon deformation of the deposit. This would permit the slippage and filling in of the inverted cones as soon as those adjacent to the base are parted. Photomicrographs of the cross section of a dome should shed some light on this phase of the structures.

"Figure 12 is a rough diagram illustrating one mechanism by means of which the increased area of the deposit of a conical structure does not expose the base when the latter is extruded. The diagram illustrates the filling in of crystals when those on the base are spread due to an increase in the basal area, of course, on an exaggerated basis. The loss of lustre of the polished deposit is due to the irregularities of the stressed surface, as indicated by the broken arrangement in 'B', Figure 12.

"Figure 13 shows the diagram of a structure which is probably representative of the condition found in hard deposits, as shown by the photomicrograph in Figure 1. When the basal area is increased with thin deposits, the spaces between the crystals permit the exposure of the base.

"The apparent hardening of the base by this type of nickel as shown in Figure 3B and Figure 13 is probably due to the very adherent nickel not permitting the base to exercise its full elongating properties. Removal of the nickel by various methods, leaving the copper base intact, permitted the latter to resume its former ductility. Due to the stress concentration, the propagation of the crack or notch in the hard nickel plate into the soft base copper, results in the latter cracking, too.

Deposits of hard nickel on very ductile oxygen-free copper gave similar results. The reason for the notch propagating so readily through even this ductile base was partly due to the imperfections in the rolled base used.

"*Slide* 6. When deposits of hard nickel of the thickness of about three ten thousandths are extruded by the cup test, the resulting dome of nickel is cracked, as shown in Figure 4.

"Figure 6 represents the dome of the thick hard nickel deposit shown in Figure 3B. The thicknesses of this deposit was six thousandths inches. This taken at 400 diameters. If the flat surface of deposit before extrusion were photographed at this magnification, the appearance would be almost the same. This is due to the very slight actual increase of the original area, resulting in practically no distortion of the deposit.

Slide 7. Figures 6A, 7 and 8 represent ductile deposits of nickel. 6A is the dome of the thick ductile deposit shown in preceding slides. The high magnification shows many reticulations, which appear as a matte deposit when viewed by the eye. This matte appearance is due to the irregularities in the surface by the large increase of the orginal area. The thickness of the deposit in Figure 6A is .005 inches.

"Figure 7 represents the same type of nickel when only three ten thousandths of an inch thick. The unplated copper base, when extruded to the same depth, shows the same detailed reticulations. A thickness of at least four ten thousandths is required in order to prevent the base metal reticulations from showing through the nickel deposit. No cracks are noticeable in this deposit. Figure 8 represents a thin deposit of the same type. The deposit has cracked, as it is only a little over one ten-thousandth of an inch thick. The fractures, however, are not nearly as extensive as in the case of the hard nickel deposit seen in Figure 4.

Slide 8. Absorption of gasses by the nickel deposit or inclusion of basic salts also leads to hard deposits. These, however, are easily recognized because of the coarser type of fracture and also the more or less regularity of the fractures.

"Inclusion of basic salts by deposits result in an alligator skin pattern when the dome is extruded. Figure 8 shows the effect of extrusion on a deposit of the ductile type of nickel plated at

a pH of 6.4. The magnification here is only four times. Basic nickel salts are deposited with the nickel at this pH, and the entire structure is weakened.

"Increase in the original area has occurred only in the copper, the nickel areas remaining free from reticulations. This type of deposit does not cause the base to fracture at the very low values of extrusion as does the hard columnar type of nickel.

"The same type of deposit is obtained in solutions which are poorly buffered. MacNaughton, in one of a series of papers on the hardness of nickel deposits due to bath composition, had definitely proven the presence of basic salts in nickel deposits, and photographed the structure showing this.

"Absorption of gases by nickel is a serious cause of hard deposits. Figure 5 represents the extruded dome of a hard deposit prepared under conditions which permitted hydrogen to be absorbed by the nickel. The extruded dome of hard columnar nickel shown in Figure 4 had very fine cracks which were more or less irregular. The additional effect of the gas makes the fracture very coarse and in the form of a spider web.

"A ductile nickel deposit of the type previously shown can be hardened by subjecting the deposit of cathodic action in acid or alkaline baths. Figure 11 is the extruded dome of a ductile deposit which had been subjected to cathodic action in a strong alkaline cleaning bath. The fractures are of the alligator skin type, but are much finer than those shown in Figure 9, which is due to basis salt inclusion.

"The three photographs are at different magnifications in order to bring out the desired details.

"Although a similarity of structure of the extruded dome is seen, there is a decided difference in the fineness of the structures.

"Tests were made of nickel deposits on copper sheet submitted by platers in twelve shops operated by manufacturers. In all cases but one the extruded domes were of the hard type structures, varying from that shown in Figure 5 to that of the columnar deposit free from gases.

Slide 9. Figure 10 shows the dome of a deposit of ductile nickel which was chromium plated according to usual practice before extrusion. Cracking of the deposit occurred, which, under 100 magnifications, appeared to be of the same order as that of a hard columnar deposit, but more regular in the pattern.

"The same deposit at 400 magnifications is shown in Figure 14. This shows a very fine net work near the crack. This fine cracking is due to the inherent hardness of the chromium. It is not visible at 100 magnifications. Figure 15 is a dome of chromium over ductile nickel extruded after eliminating the absorbed hydrogen. This checking or cracking is only visible at the higher magnifications, for at one hundred times none of this detailed alligator effect was noticed on the dome.

"Application of chromium, without absorption of gases, yields deposits which, after extrusion, appear to have this same fine net work. There are no cracks as seen in the dome of Figures 10 or 14.

"*Slide* 10. It was found that whenever poor adhesion was encountered, hard columnar nickel deposits of approximately .0003 inch thickness almost always became detached from the dome during the extrusion test. Heavier deposits of about 0.001 inch or over usually appeared intact. However, separation was more or less easily accomplished if the specimens were sheared and a knife or other implement inserted between the nickel and the base.

"When ductile nickel of .0003 inch had imperfect adherence to the base, the appearance of the dome of the extruded cup varied from its normal appearance to that of a decided cracked surface. Figure 16 illustrates the latter. The large fracture noticed in the dome in Figure 16, with its lesser branches, appears more severe than that of the hard columnar nickel dome of Figure 4. This effect, however, does not always appear when ductile nickel is extruded. Apparently perfect domes may occur in spite of poor adhesion. The surface appearance is probably a function of the degree of adhesion of the nickel to the base.

"Flexing of the unstressed part of the specimen by bending it caused the nickel to part from the base close to, but not over, the extruded area. This is a rather odd condition which often arises when the poorly adhering ductile nickel will peel at points all over the specimen save on the extruded dome.

"Figure 17 is a photograph of a specimen which, when flexed, caused nickel to part from the base all over the surface, save on the dome of the extruded cup, which gave no indication whatever of poor adhesion. The crack shown in Figure 16 was taken from

this same dome. In some specimens, ductile nickel, however, will occasionally part from the dome as well as from the unstressed part.

"FLANGED CAP ADHESION TEST

"The extruded cup test is considered entirely unreliable for determining degree of adhesion of deposits. The flexure test was more indicative than the extrusion test, but this was also unsatisfactory because heavy deposits of ductile nickel of about 0.001 inch gave no indication of poor adhesion when subjected to either of these tests.

"Hothersall, in a recent paper, described tests for adhesion. However, none of these were practical for rapid production testing purposes. In the case of thin deposits of .0003 inch, parting of poorly adhering ductile nickel from the base was very often all but impossible.

"*Slide* 11. As all of the material processed in regular production was to be subsequently fabricated into articles as illustrated in Figure 18, a new adhesion test was developed, which test also indicated the degree of ductility of the deposit. The test furthermore helped to estimate the maximum deformation permissible before the polished deposit would lose its lustre.

"*Slide* 12. The apparatus consisted of an ordinary punch press with a set of adjustable dies for drawing a flanged cap. Figure 19 shows a full size view of a test specimen. The depth of the cap is adjustable from 0 to 0.5 inches. The dies can be set for any desired gauge.

"The specimens are usually tested to a point which will fracture the cap. This provides information as to the ductility of the base and adhesion of the electrolytic deposit. The intact part of the draw shows how drawing affects the structure of the deposit. Deposits of nickel over 0.002 inches thick will not evidence poor adhesion as readily as do thin deposits, and, unless the cap is fractured, may not be detected. Fracturing of the cap will disclose poorly adherent deposits of nickel of almost any thickness.

"This test has proven entirely satisfactory for testing adhesion and ductility of metallic or non-metallic coatings on base metals of sheet steel, tinplate, zinc, brass, copper and monel.

"CONCLUSIONS

"1. The ductility of nickel deposits in a function of crystal structure, absorbed gases, and entrapped basic salts of nickel.

"2. Nickel deposits of conical or pyramidal crystal structure are very ductile when free from absorbed gases and entrapped basic salts.

"3. Non-ductile or 'hard' nickel deposits are of an acicular or columnar structure when not 'hardened' by the presence of gases or basic salts.

"4. Ductile nickel deposits up to 0.01 inch have little or no effect upon the base metal insofar as apparent variations in the ductility of the latter are concerned.

"5. The non-ductile, fibrous type of nickel deposits causes an apparent hardening of the base. This is probably due to notch propagation through the copper by transmission of fractures in the nickel deposit when the material is subjected to deformation.

"6. The inherent ductility of the copper is not altered by the application of the non-ductile nickel. When the latter is removed, the base copper is found to be as ductile as it was prior to the application of the deposit.

"7. A ductile nickel deposit on copper can be made brittle by subjecting it as cathode to alkaline electrolytes. Unplated copper is not noticeably affected by this treatment.

"8. Chromium may be applied to nickel without embrittling a ductile nickel deposit.

"9. Extrusion cup tests on poorly adherent ductile nickel make the nickel appear hard, but does not necessarily cause peeling of the same.

"10. A test for adhesion and ductility of electrolytic nickel and other coatings on sheet metal by stamping out a flanged cap is more reliable for determining adhesion than any other test used for this purpose." (Applause)

CHAIRMAN SLATTERY: Mr. Faint will answer any questions regarding Mr. Romanoff's paper.

MR. FAINT: I will answer them either by taking the questions down and then writing you, or, if I do know the answer, by giving to to you immediately.

MR. HOGABOOM: Mr. Romanoff's paper certainly is of con-

siderable interest, and it shows that you can obtain hard deposits. It is too bad that he does not tell the conditions under which these are obtained; nevertheless, that may be a part that he wishes to keep for commercial reasons.

In the paper that was presented at the Electro-chemical Society meeting at Asheville on April 26, 27 and 28, of which this is a repetition, he states that "it will be noted in Figure 2 that the deposit has a fine grain structure when first deposited. This then builds up into a conical structure. The base does not have any apparent influence upon the nickel structure." And he refers to "Electroplating and Electroform," by Blum and Hogaboom, McGraw-Hill, 1924, page 87. I am sorry that Mr. Romanoff did not refer to the later issue, that of 1930, and also that he did not refer to a paper by A. W. Hodesell, presented at the same meeting, on "The Adhesion of Electro-deposited Coatings to Steel." Had he done that I do not think his statement would have been made regarding the structure of the deposit not following the structure of the base metal, and I am wondering whether some of the results that are being reported, that have been reported in this paper, have not been due to the structure of the base metal.

It is well known that polishing flows a surface, and that you have an entirely different electro-deposited structure upon a buffed surface than if the buffed surface has been removed and the structure of the base metal has been exposed.

(*Slide*) The bottom of this photograph is electro-deposited nickel, and you have the line of junction there. The upper part is the deposit of nickel. Evidently the structure of the electro-deposit has followed the structure of the base metal.

(*Slide*) I am afraid that what has happened can be illustrated in this photograph. The bottom is copper, which has been annealed at a high temperature, allowed to cool in the furnace, so that you have a very coarse structure, and then it was polished or buffed. You will see, between the nickel deposit and the base metal, a distinct line showing the flowed surface, and then you get the columnar structure such as was told of by Mr. Romanoff.

Now, that is true of other metal deposits, and I would like to show you two other photographs illustrating that.

(*Slide*) Here, on your left, is copper, and you will see a line running straight up and then, a part of the way up, is electrodeposited copper. You will notice that directly next to the base metal, which had been polished, there is a fine structure, and that finally grows to a larger structure. That fine structure is due to the flowed surface of the sheet copper. However, if that is taken out and then dried and slightly etched, and then put back into the solution and replated, the structure of the deposit follows distinctly the structure of the base metal.

(*Slide*) Here you have a better picture of that, in that the bottom there is the basis metal. That was put through a bright dip after polishing or buffing, so that the amorphous skin was removed, and then the deposit of copper was put on that, and you will find that there is a distinct following of the structure of the basis metal in the structure of the deposit.

MR. FAINT: Mr. Hogaboom had warned me that his remarks were coming. The only thing I can say here is that these hard and ductile deposits were produced at will on the run of sheet metal with which Mr. Romanoff was experimenting. In other words, he can produce the hard acecular type structure or the conical, soft, ductile type structure nickel on the common sheet run of material that he is plating. Consequently, I am at a loss to explain the apparent commercial production which the author of this paper has in the light of the clearly-proved photomicrographs which Mr. Hogaboom has produced. Therefore, I will communicate with Mr. Romanoff, and he and Mr. Hogaboom can thresh this thing out and perhaps give us the tie-up and complete explanation of this question.

MR. GEHLING: Were those pieces shown in the four slides just hung in a still tank, or an agitated solution?

MR. HOGABOOM: It makes no difference whether they are hung in a still tank or an agitated solution. It is merely a question of the amorphous skin on the flowed surface of the basis metal, and evidently Mr. Romanoff has taken the regular mill stock. That mill stock has been rolled; it probably has an oxide surface on it, and if you will favor me with your attendance tonight I will show you some pictures on the effect of oxide coatings on this same thing. It makes no difference whether it is an agitated or a still tank. You get the same structure following.

MR. GEHLING: I thought it might change the structure in agitation. Some of them have led us to believe that in moving we get a different structure. Naturally we can get it plated faster and get more on there.

DR. BLUM: I thought we had better get Blum and Hogaboom over here together. I want to ask Mr. Faint whether, in the copy of the paper as prepared for these proceedings, the composition of the solutions used is stated.

MR. FAINT: The composition of the solution used is not stated in the paper presented here. In the Electro-chemical paper it is stated to this extent, that it is described as a modified watts nickel bath of approximate composition indicated and operated under conditions as noted. Then it gives the single nickel salts, sodium chloride, boric acid, and sodium sulphate contents, and the temperature, pH, and current density.

A word about this is all that I need say. By varying those factors you get the different compositions of nickel deposits, and Mr. Romanoff intends, in due time, to get out a complete correlation of those variables in a subsequent paper which will show the effect of these. I believe the withholding of these is not so much a commercial secret as it is a desire on the author's part to completely correlate the various factors in the solution.

MR. HOGABOOM: I would like to amplify Mr. Faint's statements, if he will permit me. The formula for the solution is:

Single nickel salts	27 ounces
Sodium chloride	5 ounces
Boric acid	4 ounces
Sodium sulphate, anhydrous	9 ounces
Temperature	68° to 122° Fahrenheit
pH	4.6 to 5.8 Colorometric
Current density	6 to 8 amperes per sq. ft.

DR. BLUM: That is the point to which I wish to call attention, that he has given a range of conditions without specifying the particular combination of conditions that was most satisfactory to produce either a soft or hard deposit, and I am glad to hear that that will subsequently be published, because that perhaps is the most important thing for the electro-plater to know—how to change the character of his deposit by changing either the

composition of the solution or the tempertaure and current density.

In this particular case I may illustrate it by saying that in the printed paper he refers to the use of sodium sulphate. It has been previously shown that by adding sodium sulphate to a nickel bath you produce harder deposits, so it follows that if you want to produce a softer nickel deposit you would not use sodium sulphate. If you did, you would have to change the temperature or some other factor.

This paper will be more valuable when we learn what combination of conditions is best suited to give us a hard or soft deposit, depending on which we want.

MR. FAINT: I might add that the fact that the definite operating conditions are not given is because, again, the author wants to be as sure of his ground as he can be. The reason for putting out this first paper without the other was that he thought the method of testing the deposits would be something that he could release immediately, and thereby give us an idea of how we can get consistent checks in testing a deposit for ductility.

MR. MEYER: I would just like to say something with regard to this amorphous film that has been mentioned by Mr. Hogaboom. I believe the latest work in research in metallurgy seems to indicate that the amorphous condition in metal is something that either does not occur or occurs very seldom. There has been no real proof that the amorphous condition does exist.

According to Gow, who presented a very remarkable paper at the A. S. T. M. meeting in Chicago last year, the amorphous condition is really a condition of small crystallites, rather than the amorphous condition of metal which assumes no orientation whatsoever of the atoms in relationship to one another. That viewpoint will not change the structure in any way from those shown by Mr. Hogaboom. It is just a little different interpretation of the amorphous film.

Ordinarily in a metal you have fairly large crystals before you co-work it. When you co-work this metal you get crystalline breakdown.

They have done a great deal of work in using the X-Ray in

trying to find out just how great this crystalline breakdown is, and they have not been able to prove, either by the X-Ray methods or any other, that the amorphous condition does exist. It seems most logical that the crystalline structure does occur in these conditions. If we have large crystals on a surface and we co-work it, the tendency in that is to get breakdown of that crystalline structure, and as you do, you get a greater amount of grain boundaries, and from X-Ray work it seems that the ultimate size ranges to the order of 1,000 atom diameters, and in most cases this amorphous skin is really a crystalline condition.

I believe that is something rather recent, Mr. Hogaboom, and the question of talking about amorphous metals does not seem quite right in the viewpoint of metallurgy. Perhaps Mr. Anderson, who has done considerable work on the crystallography of zinc, might be able to say something about that.

MR. A. H. GRAHAM (University of Pennsylvania, Philadelphia): I would like an opportunity to say just something in connection with the remarks of the last speaker. The slides which Mr. Hogaboom showed you were presented in a paper which offered an explanation similar to what you have presented. I think the paper was presented in about 1923, and the thought expressed in that paper was that you got reproduction of the base metal in electro-deposition, but that the deposit only reproduced the surface that was exposed.

Now, if you took that piece of metal and buffed it, whether you wanted to call the surface film "amorphous" or not, is arbitrary. It is a loose expression, and only applied loosely; but there is a statement in that paper to the effect that the deposit reproduces the surface that is exposed, and we can make this comparison, that if we have a very coarse-grained annealed surface exposed, entirely free from any film on the surface such as you would get by bright dip, you get a very coarse reproduction in the deposited metal.

Now, if you have a buffed surface, the surface is broken up to such an extent that it appears not to reproduce. Nevertheless, we believe it reproduced the surface that was exposed. I think the term "amorphous" as applied to the surface is one of general usage, but is not what we actually mean.

Pictorial Study of **Plating Conditions**

MR. WILLIAM M. PHILLIPS
Research Engineer, General Motors Corporation, Detroit, Mich.

Mr. Phillips' paper was one of the high lights of the convention because of its novelty and the easy and interesting manner of its presentation by the author.
Our readers are urged to attend the meetings where Mr. Phillips' paper and pictures are shown. It's worth going miles to see.—*Ed.*

THIS presentation we are going to make now is a study in which we want you all to take part. We do not know exactly what is going to happen; we have here some plating solutions that are a little too small to dive into, but I expect you have all had experiences where you would have liked to dive down into the bottom of a plating solution to see what was going to happen and then, if you could not get it corrected, you did not know whether to come up or not.

Our first idea was to make some moving micro-photographs. We did not find that practical, and then Mr. Wirshing thought of using a projectoscope and putting various plating solutions on the screen.

(*Screen*) The first solution that is up there is a nickel solution which contains 240 grams of nickel, high pH bath, with a .20 carbon anode. One of the things you will notice is the formation of streams of solution. You will notice, up there in the anode, that the concentrated solution is beginning to run off, but here the dilute solution is going the other way. I might remark, first of all, that the thing shows upside down, this being the top of the solution.

Now the current has been increased. The films are not quite so clear. A thing that you will notice in all the nickel solutions is that a bubble forms, once in a while, in one place, and gets larger and larger and then finally breaks, but after it breaks another bubble forms in exactly the same place. Everywhere that happens a pit is always present.

These take a little time to run, and I have had some terrible threats from people who were going to heckle me about this, anyway, so here is where I am going to give them a chance.

While we have this up and running, I want you to ask any questions that you care to.

There is one thing that I might say in advance of them, that the size of the tank here is about 4″ by ¾″. The nickel anode is about ½″ wide, ¼″ thick, and 4″ long, and the cathode is 3/8″ by 4″, and when we apply .1 ampere that is equal to 5 amperes per square foot.

This is the anode here. You will see the concentrated solution coming off that, and here you will notice a condition which naturally occurs in a high pH bath at high current density. We are getting some very nice peeling to start with. We might say that it is not entirely an accident. We hoped it would happen.

DELEGATE CASTELL: How did you clean the piece?

MR. PHILLIPS: The cleaning was very carefully done. We have some acetone, and we used the most modern degreaser we could find.

Question: Are those bubbles due to heat?

MR. PHILLIPS: Those are not necessarily bubbles.

One thing that is noticeable in all these experiments is that there is a good bit of foreign material thrown off the anode. It may be fine particles of nickel. In this particular case I suspect that this material running up (and also going down, to some extent) is possibly carbon. We find that when we run this same anode for quite a period of time that stops, particularly after it is wiped off once, but this is a brand new anode, and we have just two of them to work with. We noticed that same condition when we first put it up.

Now, as that goes on, here is a prophecy that I can safely make: This concentrated solution will gradually build up to such an extent that the solution will become stratified. That is due to two causes, one, that the depleted solution is coming up, and the concentrated solution is coming down.

That explains a thing that we have always explained by one cause. We have presumed that the piece at the bottom of the rack got heavy on account of current distribution, but those pieces also get heavy where the solution is not properly agitated due to this fact.

CHAIRMAN BLUM: May I call your attention, Mr. Phillips, to the fact that with an acid copper solution your copper sulphate

accumulates at the bottom, but your sulphuric acid accumulates at the top?

MR. PHILLIPS: That is true and, of course, there is in a measure some change here, but it would not have the same effect.

I think, considering the time that we have, that we had better discontinue this one and put up the depolarized anode at a high pH. That is a high carbon anode.

(*Screen*) This method appears to us to have some possibilities in making studies of various things. You noticed the pits forming. In fact, we may be able to preserve some of these panels so that you can see the pits on examination. You noticed that there was a lot of hydrogen always coming up, which seems to do no harm at all. It is just where there is a concentrate that you get into trouble with pitting.

In addition to the twenty-point carbon we have tried some ten-point carbon anodes that showed less carbon formation. This is at twenty-five amperes per square foot.

That is a sheet anode. The sheet is 3/8" wide by 4" long, and we are showing the edge of it.

Unfortunately these have to run a little while to develop the things that you want to see. I may say that some of this dirt that you see dropping there is coming from the bottom of the tank. These tanks are made out of brass and glass, and in order to keep the brass from being exposed we coated the tanks with hydrolene, and that has started to chip off. It was just discovered today, too late for a new application. That will also account for a little more pitting than is normal.

The pH of this bath is 5.5, electrometric.

CHAIRMAN BLUM: I wish to call attention to the very distinctly lighter color of that layer next to the cathode, showing how much more depleted it is there.

MR. PHILLIPS: Yes, and that is more concentrated running down here. The gravity of it is much greater.

I hardly expected, gentlemen, to have two peelers right in a row. Production is not so very good!

Now, as we run this, of course, this bath will become somewhat more alkaline. It is probable, and quite certain, that we will have a lot of floating material in the bath, due to the fact that the solubility of that material in the high pH bath is not very

great. You can see that floating all through here now. Some of those are bubbles; some are undissolved material.

You will notice what a beautiful bunch of pits we are getting in here, and how this is peeling at the same time.

CHAIRMAN BLUM: How strong is the nickel solution?

MR. PHILLIPS: 240 grams per liter.

I think, gentlemen, that we have run that long enough there to put in a little sulphuric acid.

MR. MEYER: Do you not think those are convection currents more than stray currents?

MR. PHILLIPS: There goes our acid.

Question: What is the distance between the cathode and the anode?

MR. PHILLIPS: One and one-half inches.

MR. HOGABOOM: What are the spots on the left-hand side?

MR. PHILLIPS: Bubbles on the glass.

We had intended, Dr. Blum, to plate these for five minutes and then put up a new solution in which we knew the pH and would make it low. Probably that is the best thing we can do. That clearly is plated very badly now, because it peeled before.

Suppose we do that, gentlemen. We do not want to use the whole evening on this. Suppose we put up the polarized anode with the low pH bath of known concentration. This will be somewhere in the neighborhood of 2 pH.

It takes about a ten- to fifteen-minute operation to produce a very beautifully stratified solution. That is true either of the nickel or of the copper plate. We are not going to show some of the other solutions we have made studies on because they are not very spectacular. The same is true of cadmium, although in any case it may be possible to find out some very interesting things by carrying these out.

(*Screen*) Now we will plate for five minutes at the same current density. I do not know whether we have a peeler or not. We hope not, this time.

MR. MEYER: You can see the light line getting more and more distinct.

MR. PHILLIPS: The magnification we have on the screen in our own auditorium up at the building is about thirty-three. I doubt if it would be quite as much on the screen as we now have it fixed.

CHAIRMAN BLUM: I might state, Mr. Phillips, that although such pictures as this have been shown, such demonstrations have been made, to show what happens in plating, I believe this is the first time I have ever seen it demonstrated as a means of studying. The other has been purely a stunt.

MR. PHILLIPS: We realize that the use of a magnifying projectoscope is not entirely new, but we did feel that there had been no use made of it to make a study of plating.

MR. ANDERSON: We had better have some peroxide.

MR. PHILLIPS: We need some. We could show the addition of an oxidizing agent to reduce pitting, which it certainly does do very nicely. We are bound to have some pitting in these solutions, even if we run them for a few minutes only, in these tanks, on account of the brass.

I am very sorry, gentlemen, but we have another peeler. We have just batted exactly 100% so far.

CHAIRMAN BLUM: Is there a possibility that your solution heats up slightly, which may increase the tendency for bubbles to form?

MR. PHILLIPS: The solution does heat up. The light is back of it and the current is on, but for this time of operation there has not been a great rise in temperature. You will at least observe that this is not peeling nearly as badly as the others.

MR. HOGABOOM: Are those hydrogen bubbles on that cathode?

MR. PHILLIPS: Yes.

MR. HOGABOOM: Are they H2, H3 or H4?

MR. PHILLIPS: Unfortunately, they did not label themselves.

CHAIRMAN BLUM: It is quite safe to say that they are H1, because that comes off more easily. An old used chromium plated bath is one of the sources of heavy water.

MR. PHILLIPS: I may say that we did not make this up with heavy water. We just ran out of it at the laboratory, and could not make it up with that.

Those bubbles, I think, are very interesting—the way they grow and fall off. Yet there is a lot of that coming off without doing a bit of harm. It is possible, sometimes, to put something on the cathode to make those form, although we have not tried to do that.

MR. GREENBLATT: Why did the bubbles in the last picture come up on this side of the anode, and not now?

MR. PHILLIPS: I think the reason is that the anode is now more soluble. It does not involve any gas, due to solubility. All that current is working. We have, probably, an efficiency of 100 on the anode side.

Question: Why is there such an activity back of the anode, without so much in front?

MR. PHILLIPS: That activity, I believe, is just a question of material being trapped back in the bottom, and then rising. I do not know why it is that it happens to go there. It is just a question of the convection currents.

CHAIRMAN BLUM: Are the anodes and cathodes completely submerged so that the solution can come over them?

MR. PHILLIPS: They may not be. We are going to show you the top of the solution, which is rather interesting just as a thing to look at, a little later.

The next solution we are going to put up is a copper sulphate solution.

(*Screen*) That has a lead anode. The lead anode, you see, is not going into solution at all, and therefore there is a lot of gas coming off, and naturally the anode efficiency is very low. It is above zero.

CHAIRMAN BLUM: Does the anode merely cut off a cross-section of the jar?

MR. PHILLIPS: There is some room for current to go around it.

CHAIRMAN BLUM: There seems to be more gas in back than in the front.

MR. PHILLIPS: Of course, that is partly due to the way you focus it. Possibly if we turned the anode a little bit it might turn the other way.

You will notice that there is some hydrogen given off on account of the current density used. If you run this for fifteen minutes you get the most beautiful stratification that you ever saw. It would be a very deep blue on the top, and various layers would be formed there. It would be almost clear up here.

Let us put in the copper anode now.

(*Screen*) You can notice the difference immediately. Do you see the copper going into solution there, and the lack of gas bubbles? We will move on to the next solution. We will not wait for stratification on this.

(*Screen*) There you get a little more of that line across here. You see that the cathode is building up very rapidly in a somewhat granular form.

Question: Does this not show in a qualitative way what anode and cathode current efficiency we are getting?

MR. PHILLIPS: It certainly would.

Another thing it shows very clearly is that a great deal of the harmful extraneous material in the plating bath comes from the anode. If it were possible to run these for just a little time, that would be very apparent. That I refer to particularly in the nickel solution. It shows the necessity of bagging anodes or using some other means of keeping that dirt out.

(*Screen*) This solution is a nickel sulphate solution containing only nickel sulphate, 240 grams per liter, pH about 2. I will call to your attention the fact that even in the absence of chlorides the anode is apparently going into solution; but you will see that it is not going in as rapidly as it does when we put a little chloride in, which we will do.

MR. MEYER: Have you noticed whether the rapidity of dissolving of nickel decreases as time goes on, or does that seem to stay as it is?

MR. PHILLIPS: I am sorry, but I cannot answer that question intelligently because we have not run this long enough to answer it. You see, we started this experimental work about a month ago, and we have not really had time.

Let us drop the chloride in. That is sodium chloride.

Now, you will notice how much more pronounced that was at the beginning. The anode does dissolve faster. All of these things are magnified by just a little more time. If we were able to run this for five minutes before making this addition, you would see it much more clearly.

Question: About what is the cathode efficiency?

MR. PHILLIPS: If you are running a low pH bath you very naturally expect a lower cathode efficiency. There is a good deal of hydrogen given off, and it takes current to make the hydrogen, so that particular current can not be used in depositing nickel. The efficiency of a nickel bath varies from (at a low pH) about 85% to (at a higher pH) about 94% or 95%, or even, sometimes, up to 100%.

MR. MEYER: There does seem to be a migration of those particles to the cathode.

MR. PHILLIPS: That is true. The thing is just a matter of chance. We have had particles loose themselves from the cathode and plate on. Then we have been able to take the cathode out and find them there as a projection.

Question: What is that which seems to be a white hair on the back of the anode?

MR. PHILLIPS: Well, that is more a question of movement. That is a concentrated solution running off the anode.

MR. HOGABOOM: What effect has boric on it?

MR. PHILLIPS: It is hardly noticeable.

MR. HOGABOOM: Have you added hydrogen peroxide?

MR. PHILLIPS: That is an interesting demonstration to reduce pitting, but it means, of course, plating for some little time and then adding the peroxide and plating for some little time again.

MR. HOGABOOM: What is the effect on the cathode?

MR. PHILLIPS: Your first cathode will be badly pitted, the second not so badly pitted and, if you run a third, it will not be pitted at all, perhaps.

MR. HOGABOOM: How about the adhesion of hydrogen bubbles?

MR. PHILLIPS: Well, there is a great deal of difference. You do not see bubbles like this forming.

Question: Is it possible that we see a movement of depleted solution upward? It is not all a hydrogen stream.

MR. PHILLIPS: By no means. By reducing the current density you can see that much more clearly.

Let us go on to the next one. That matter of gassing is, I think, rather interesting.

Some time ago I did a lot of copper deposition, and by putting too little air in the tank to agitate it I got a lot of pits. By putting in a lot of air I did not have any pits at all, and that is certainly true of our chromium—that our heavy evolution of gas does us some good, and I think that is true of some of our nickel baths.

(*Screen*) We have a bent cathode here. It shows here that we trapped a bubble in putting it in—in fact, two of them, one small and one large. That shows the importance of the way

you put a thing in the bath. We will show you now how this thing behaves. Do you see the white line now? It is very clear on this one. You can see the depleted solution running off there very clearly.

Question: What percentage of current is going on that point there?

MR. PHILLIPS: It is certainly very much higher. There is a very nice example of distribution or the lack thereof and the fact that you can trap a bubble or form one of hydrogen and not get any plate.

MR. MEYER: I wonder if you could agitate the solution adjacent to the cathode so that we can see whether the white layer of depleted nickel would tend to disappear.

MR. PHILLIPS: If we had a pipette here I think we could do that. It does do that, absolutely.

CHAIRMAN BLUM: It has largely disappeared from the gas agitation.

MR. PHILLIPS: I think we will go on to our next tank. We will put the nickel plating solution in so that we can see the top of it.

(*Screen*) I think the effect of the gas here at the surface is rather interesting and possibly somewhat surprising.

MR. MEYER: It illustrates the effect of surface tension.

MR. PHILLIPS: Surface tension, of course, is exactly what is doing that.

There is also something that I do not understand, and that is, when we have operated the solution for some little time there is a very thin layer of concentrated solution right along that line, whereas just below it it is quite dilute. In fact, we have seen a lot of things that we can not possibly explain.

CHAIRMAN BLUM: One of the most surprising things is the large amount of general convection stirring through that whole solution. You would expect to find it go around more or less on one channel, down one side and up the other, but you see it coming up close to the anode as well as going down just a little further out.

MR. PHILLIPS: That is true.

CHAIRMAN BLUM: Showing that there is no such thing as a still solution.

MR. PHILLIPS: Also notice the reflection of the direction of

the stream from the surface, Dr. Blum. I think that is very interesting. You see where the hydrogen bubbles come up. The hydrogen hits the surface, and then you get a current around back in again.

We will go on to our next solution, gentlemen.

(*Screen*) We have a chrome solution there. That is a chromium solution containing sulphuric acid only.

CHAIRMAN BLUM: Have you determined the ratio?

MR. PHILLIPS: The ratio of the two solutions we are going to show is about the same so far as sulphate goes. Here we are using sulphuric acid only, and in the next we will use chromium sulphate. You will notice the formation of this black material, which we presume is reduced chromium.

Question: What is the anode?

MR. PHILLIPS: The anode is lead. This is the anode, over here.

Question: What is the material in the cathode?

MR. PHILLIPS: The cathode is made of copper, gold-plated so it would not go into solution.

We will raise the current enough in a few minutes to get the hydrogen evolution. Suppose we raise it gradually.

Question: Is that precipitate collecting in the bottom of the beaker?

MR. PHILLIPS: Now you will notice the hydrogen. That is at 100 amperes to the square foot. We are letting this run about one minute. Part of that darkening is due, of course, to the hydrogen. There is some plate on that now.

What I wanted you to see in that particular demonstration was this formation of reduced chromium, and then the fact that you could plate hydrogen there without plating chromium. Then you go on further, and you may reach an intermittent stage of plating and finally a state where it plates. If we had interrupted it at just the right place there would have been no plate on there at all.

Question: Do you find, as you increase your current density, that you get less reduced chromium?

MR. PHILLIPS: You get more. You finally build up enough reduced chromium so that it plates. In the other one it will probably plate immediately at that current density.

(*Screen*) This is a solution that is very commonly used. It has about 235 or 240 grams of chromic acid per liter. You see that we do not get the same formation of the reduced chromium at all, but we have gone into the gaseous state right away, and a very small raise will cause it to plate.

CHAIRMAN BLUM: Is that at room temperature?

MR. PHILLIPS: There has been no attempt to warm it.

Question: That other bath had not been electrolized before?

MR. PHILLIPS: Neither bath has been electrolized before.

Question: If I understand you correctly, you get more reduced chromium when you increase the current density?

MR. PHILLIPS: It is a well-known fact that you get more reduced chromium all the time as you continue to chrome plate.

Question: Proportionately, is what I had in mind.

MR. PHILLIPS: No, that would not be so, necessarily. I did not understand your question. What I thought you asked was whether the reduced chromium would increase as you plate, and it quite often does.

Question: Is there any difference between this bath and the last one?

MR. PHILLIPS: Yes. This has the same sulphate content as the other, but this is in the form of chromium sulphate and the other was sulphuric acid.

You see, gentlemen, things are going on pretty rapidly there now.

Well, gentlemen, we might have the lights. I believe that is about all of this particular presentation. (Applause)

CHAIRMAN BLUM: Gentlemen, it is a rare privilege to thank Mr. Phillips and his associates for this treat. I have no doubt that this is the first time that any audience in this country, or elsewhere, has ever seen a demonstration of this kind, actually showing what happens in electro-plating.

A CORRECTION

After proof reading the paper on "Dropping Tests for Determining the Local Thickness of Electrodeposited Zinc and Cadmium Coatings", which appeared in the March issue of the Electro-Platers' REVIEW, I noted an error which I believe should be corrected in the next REVIEW.

On page 13, line 23, the article should read "applicable with an accuracy of about ± 10 percent to zinc deposits". Criticism relative to our degree of accuracy may follow if this correction is not made.

PAUL W. C. STRAUSSER, *Research Associate.*

The Anodic Coating of Aluminum

By HAROLD K. WORK
Aluminum Co. of America

THE anodic treatment of aluminum has spread rapidly in the past few years until now it is one of the important branches of the electrolytic coating of metals. In this country alone several millions of pounds of aluminum are being anodically treated annually.

The process differs from electroplating. One difference is that from which it derives its name; the articles to be treated are attached electrically as anode rather than cathode. In electroplating, a metal is deposited on the article being coated; in anodic treatment, in effect, oxygen is deposited instead of the metal and combines with the aluminum to form aluminum oxide. Another distinction is that this oxide, after it is formed, does not dissolve on mere reversing the direction of the current flow, as is the case with most electroplates. Due to this characteristic it is possible, although rather inefficient electrically, to apply anodic coatings by alternating current. The articles to be coated may be suspended in the electrolyte from both of two rods which are connected to a transformer, giving the proper voltage. When the current flows in one direction the work on one rod is coated, but when it flows in the opposite direction the work on the other rod receives the coating. Alternating current actually has been used to a limited extent for commercial work, but experience has indicated that it requires a greater amount of electrical energy to obtain a given abrasion resistance in the coating than where direct current is employed. The latter has, therefore, superseded it.

While the process of applying relatively thick anodic coatings to aluminum has not found extended commercial application until recently, thin oxide coatings with important electrical properties have been used in electrolytic rectifiers and condensers for many years. These, however, are so thin and lacking in other properties that they have been used only for such special application. Newer

processes, which allow the formation of thicker and more durable coatings, have been developed. Flick[1] found that a dense adherent coating of oxide could be applied to aluminum by making it anode in a solution of ammonium hydroxide or ammonium sulphide. With the former electrolyte the coating is white; with the latter it is pearl gray. At a potential of 220 volts a coating forms in less than a minute. The coating may be employed for its decorative, protective, or insulating properties. Bengough and Stuart[2] in England employ a 3 per cent chromic acid electrolyte to form a gray corrosion-resistant oxide coating on aluminum. This process has been quite widely used but since the coating is still fairly thin it has been customary to employ it primarily as a base for paint. Such a finishing system of oxide coating and paint gives very desirable protection to thin sections of certain alloys in aircraft work. The voltage required to produce coatings in chromic acid is fairly high - forty to fifty volts - following a carefully defined schedule for one hour, so the process is relatively expensive. Recently chromic acid processes, employing higher acid concentrations, have been developed, which are somewhat

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simpler. Another electrolyte which also requires high voltages is oxalic acid [3, 4]. Sometimes, as in Germany,[5] a small amount of chromic acid is added to the oxalic acid. The chromic acid reacts with the oxalic acid, giving off gas, and the solution assumes a purple color, probably due to the formation of chromium oxalate. The oxalic acid electrolytes may be employed for the formation of much harder and thicker coatings than are obtainable from chromic acid but the coatings have an unattractive yellow or gray appearance.

In the United States the most widely used electrolyte is sulphuric acid, as exemplified by the Alumilite process. Hard white coatings may be applied from sulphuric acid and only low voltages are required for their application. The characteristics of the coating may be varied widely by selection of the proper concentration of sulphuric acid. Tosterud[6] has applied hard, highly abrasion resistant anodic coatings in an electrolyte of about 7% sulphuric acid. Gower[7] using 25% acid secures both good abrasion resistance and good color adsorption. Bengston[8] by using 65% sulphuric acid obtained coating which dye very readily and which may be easily formed without harming the appearance of the coating. Quite recently mixtures of oxalic and sulphuric acids[9] have been employed to secure, at higher electrolyte temperatures, the hardiness of the sulphuric acid coatings along with the white color (where commercially pure metal is treated) and the low operating voltage of sulphuric acid.

The application of the oxide coating requires certain special precautions. The solutions require exhaust systems to remove fumes; otherwise the spray of sulphuric acid will become very irritating. Also, the racks must make firm contact with the article being coated. If this is not done the contact between the work and the rack will break, due to the formation of an oxide coating between them, and the article will cease coating. The racks in the submerged portions are of aluminum; other materials for the most part would allow passage of excessive current from the racks and might dissolve rapidly. While agitation of the electrolyte in electroplating is usually harmful because it keeps particles in suspension which settle upon and roughen the finish, in anodic coating, it has been shown by Bengston[10] that agitation is highly desirable, for it helps maintain an even temperature at the surface of the work. In contrast to most plating solutions

the anodic coating solutions as a rule have very good throwing power. Auxiliary cathodes are only infrequently necessary.

The anodic treatment of small articles in quantity is quite different from electroplating such parts. This is because a firm contact must be made and maintained at one point, for it is not possible to keep changing the point of contact because of the insulating nature of the coating. The coating of such small objects is, therefore, accomplished by means of a perforated container with a screw top, which makes a firm electrical contact between the individual pieces and the rack. These constitute the more obvious differences between electroplating and anodic treatment.

The properties of the anodic coatings are particularly interesting. One of the outstanding and most valuable characteristics of the anodic coating is its high abrasion resistance. It is this property, among others, which has made the coating so useful on cafeteria trays, electric refrigerator trays, and automobile pistons. The corundum-like hardness of the coatings applied under suitable conditions may be readily observed by scratching the surface with a pointed instrument. This characteristic of the coating has been studied by revolving the coating against an Alexite wheel under a light constant pressure and observing the number of revolutions required to cut through the coating. A few typical figures showing the abrasion resistance of the coating follow:

Relation Between Abrasion Resistance and Thickness of Oxide Coatings

Thickness of Coatings Inches	*Abrasion Resistance in Revolutions*
0.00011	15
0.00019	95
0.00031	268
0.00037	365
0.00074	2563
0.00148	7061

For comparison, a finish of the durable type such as is applied to metal furniture consisting of primer, two ground coats, graining coat, and three coats of finishing varnish, having an overall thickness of 3 mils, gave an abrasion resistance of 306 revolutions and a somewhat different finish of the same thickness gave 1,095 revo-

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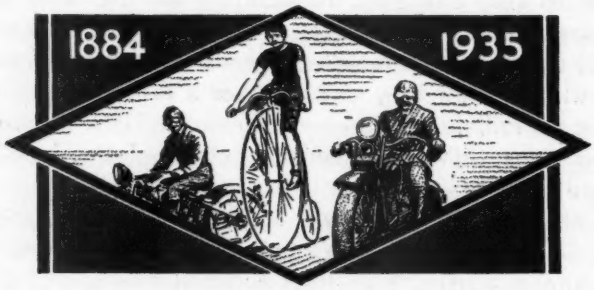

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lutions. Thickness for thickness, therefore, the oxide coating is much more wear resistant than the paint films just mentioned. Of course, as would be expected, the coating conditions, and the composition and temper of the alloy being coated all affect to a greater or less extent the hardness of the coating.

The adsorptive properties of the coating were discovered by Flick[1]. He found that certain organic dyes could be readily adsorbed in the oxide coating. The color penetrates throughout the coating giving deep colors which, however, have an underlying metallic sheen which makes them unique and particularly attractive. It is of course recognized that the organic dyes, as in the case of dyed fabrics, will eventually fade on continued exposure to the weather. Tosterud[11] has shown that where greater light fastness is needed, mineral pigments such as metal oxides may be precipitated in the coating. These mineral pigment colors are restricted to somewhat less brilliant colors than the dyes. Such finishes, when properly applied, have maintained their original color for several years of exposure to the weather but the ultimate life of the coatings is not yet known.

The fact that the coatings adsorb materials so readily is not always advantageous. For certain types of service, such as on cafeteria trays, it is essential that food products coming in contact with the coating by accident should not stain it. Bengston[12] discovered that treatment with boiling water will effectively "seal" the coatings and prevent them from staining or dyeing. Such a treatment, as is shown by X-ray examination, changes the amorphous alumina originally formed, in part at least, to cyrstalline alpha-monohydrate. Accompanying the change in the crystal structure is a marked increase in the corrosion resistance of the coating. Edwards[13] has shown that it is possible to further increase the corrosion resistance of the coatings by adsorbing substances such as silicates or chromates in them. For example a group of aluminum alloy specimens were oxide coated electro-chemically in a sulphuric acid electrolyte and part of the group was treated with a soluble chromate. After 52 weeks in a 20 percent salt spray the specimens with the chromate treated coatings lost only 4.5 percent on the average of their elongation, while those without this treatment lost on the average 16 percent.

The oxide coating in dry form is an excellent electrical insulator. The break-down voltage of the film is roughly proportional to

the thickness of the coating. A few typical figures for coatings on commercially pure metal follow:

Break-down Voltage of Coating

Thickness of Coating Inches	*Breakdown Voltage*
0.0002	180
0.0004	280
0.0006	340
0.0008	380
0.0010	420

These values may be increased by as much as fifty per cent without the introduction of any organic matter in the coating by use of a "sealing" treatment mentioned above.

One characteristic of the coating which has not been mentioned is its adhesion. In electroplating special precautions must be taken to ensure adhesion of the coating; in anodic coating there has been no such problem for the bond between the aluminum and the coating seems to be every bit as strong as the coating itself. Since the coating is formed from the aluminum, grease or dirt on the metal surface may prevent formation of the film in local areas but it will not affect the adhesion of such coating as is formed.

It is of interest to consider briefly a few of the many commercial applications of the finish. Perhaps the largest single application is in trays and related parts for electric refrigerators. Another field which will in all probability surpass it is the use of Alumilited aluminum for architectural work. Store fronts, spandrels, and

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escalators in department stores are a few examples where the hard, corrosion-resistant finish is finding rapidly increasing application. Cafeteria trays are being coated to prevent them from smudging white articles with which they come in contact. Automobile pistons and trim are being coated in increasing amounts. In addition a host of miscellaneous novelties are being attractively finished in Alumilite colors. The steadily increasing use of this finish indicates that it is going to occupy a prominent place in the field of electrolytic finishes.

[1] Flick, U. S. Patent 1,526,127 (Feb. 10, 1925)
[2] Bengough & Stuart, U. S. Patent 1,771,910 (July 29, 1930)
[3] Kujirai & Ueki, U. S. Patent 1,735,286 (Nov. 12, 1929)
[4] Work, U. S. Patent 1,965,684 (July 10, 1934)
[5] Schmitt, Hauszeitschrift d. V. A. W. u. d. Erftwerk A. G. für Aluminum 4, 79 (April June 1932)
[6] Tosterud, U. S. Patent 1,900,472 (March 7, 1933)
[7] Gower, U. S. Patent 1,869,058 (July 26, 1932)
[8] Bengston, U. S. Patent 1,869,041-2 (July 26, 1932)
[9] Work, U. S. Patent 1,965,682 (July 10, 1934)
[10] Bengston, U. S. Patent 1,891,703 (Dec. 20, 1932)
[11] Tosterud, U. S. Patent 1,965,269 (July 3, 1934)
[12] Bengston, U. S. Patent 1,946,147 (Feb. 6, 1934)
[13] Edwards, U. S. Patent 1,946,151-3 (Feb. 6, 1934)

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Edwards, Tosterud, and Work, Electrical Engineering June (1932).
Edwards, J. D., Ind. Eng. Chem., News Ed. 11, 328 (1933)
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Mantell, C. L., Metal Cleaning & Finishing 6, 11 (1934)

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The Abstract Section

T. F. SLATTERY, *Chairman, Program and Educational Committee*

The Electrolytic Growth of Metal Crystals. I. Growth of Silver Crystals out of Aqueous Solutions, T. ERDEY-GRUZ, *Zeit. fur. Physik. Chem., Ab. A*, vol. 172, p. 157, 1935.—The author makes a very extensive study of the crystals of silver that are deposited from the silver complexes, iodide, bromide, chloride, and the ammoniacal one. It is found that the growths obtained are in general in accord with the Kossel-Stranski theory of crystal growth. The author finds that the rate of nuclei formation is not only conditioned by the polarization potential, but also by the exact dependence of the polarization potential upon the current density. The article is profusely illustrated with pictures of different crystal types obtained.

C. KASPER.

The Electrodeposition of Nickel-Iron Alloys, E. RAUB and E. WALTER, *Zeit. fur Elektrochem.*, vol. 41, p. 169, 1935.—A study of nickel-iron depositing bath, in which citric and tartaric acids are employed, for complex formation and for buffering. In these solutions, which were studied through a pH range of 3 to 10, it was found that the iron content of the deposit dropped very rapidly at a pH of 6. The best deposits were obtained in a relatively acid bath. The deposits were pitted, and in general not very coherent. Increase of temperature increases the nickel content of deposits. The solutions were high in nickel content and relatively low in iron.

C. KASPER.

The Analysis of Plating Solutions and Deposits. WALTER R. MEYER. *Metal Cleaning & Finishing*, vol. 7, No. 2, Feb. 1935, p. 61-64.—The author gives a brief summary of methods of analysis which have been published in 1934. In all cases reference is made to the original paper. Methods for solution analysis include Tin (Alkaline) Copper, Silver, Boric Acid in Nickel, Cadmium. Determination of thickness of deposits includes spot or drip tests for chromium, tin, nickel, the Preece Test, microscopic and electric measurements.

E. T. CANDEE.

Recent Advances in Metal Cleaning Technology. Part

II. R. W. MITCHELL. *Metal Cleaning & Finishing*, Vol. 7, No. 2, Feb. 1935, p. 65-68.—The newer types of cleaners are briefly described. These include Naphthlenic soaps and sulphonated cleaners. The latter type have been used for some time in the textile industry but have only recently been applied to the metal cleaning industry. E. T. CANDEE.

The Effect of Oxidizing Agents on Nickel Deposition. A. W. HOTHERSALL and R. A. F. HAMMOND, *Metal Industry* (London) p. 201, Feb. 15, 1935, and p. 251, March 1, 1935—Hydrogen peroxide is widely used to prevent pitting of nickel plating. Nickel nitrate has been recommended for the same purpose for use with hot agitated solutions. The action of these is primarily one of hydrogen depolarization. The discharge of hydrogen ions is facilitated, thus causing a lowering of the cathode metal efficiency. The effect of reducing the throwing power has been brought out. At a given pH, these oxidizing agents in the plating bath cause increased hardness and brightness of the deposit, and, in excess, give rise to brittle and curled deposits. These effects are most marked at high pH. With increase in concentration of these agents, the hydrogen discharge reduces to zero and then recommences with further increase of concentration, except in the case of nitrate added to a bath buffered with ammonium sulphate (not containing boric acid.) Concentrations required to suppress pitting by inhibiting gas discharge under certain given conditions are tabulated. Hydrogen peroxide, unlike nickel nitrate, oxidizes ferrous iron in the bath and thus may remove impurities by the oxidation and precipitation of iron compounds. C. T. THOMAS.

Electrolytic Zinc Plates. C. C. DOWNIE, *Electrical Review*, Vo. 115, Aug. 3, 1934, page 150.—Zinc plates for photo-engraving can be made by electro-deposition in much the same manner as copper sheets. Electrolyte usually contains 8% zinc sulphate with sulphuric acid. The voltage required depends upon the acidity. Cathode plates are oscillated to cause the zinc to be deposited uniformly as a flat surface. Electrolyte is agitated continuously and is repeatedly filtered to remove suspended impurities. Thickness of deposit and surface characteristics are controlled by acidity and rate of circulation of the electrolyte and by the current density. This makes possible in one operation the production of a finished product, hitherto

made by rolling out the plates, heat treating them, and then sand blasting or treating them chemically to obtain the desired surface. *M. A.* 3, p. 108, 1935. M. S.

A New Process for the Cleaning of Metals. U. C. TAINTOR. *Wire and Wire Products.* Vol. 9, Nov. 1934, pages 399-400.—The absolutely clean surface which is needed for electro-plating of metals is obtained by immersing the article in a bath of fused-sodium salts in which the nascent metallic sodium during electrolysis produces in a few seconds a non continuous clean metal surface with no metallic inclusions than can be obtained by pickling. The process has the economical advantage of using no acids therefore elimintaing the problem of disposing of waste acid; furthermore loss of metal is practically eliminated. Steel is not embrittled through absorption of H, and can even be tempered while being cleaned. No preliminary degreasing is necessary. The method can in many cases replace sand blasting. Steel cleaned in this manner unlike steel cleaned by pickling, can be stored without rusting. The cost is about 25-50c per ton of metal treated; 5-20 K W-hr. with 5-10 lb. of soda per ton of metal are required. *M. A.* 2, p. 62; 1935. H. A.

Recent Advances in Metal Cleaning Technology. Part II. R. W. MITCHELL, *Metal Cleaning & Finishing*, Vol. 7, No. 2, Feb. 1933, p. 65-68.—The newer types of cleaners are briefly described. These include Naphthlenic soaps and sulphonated cleaners. The latter type have been used for some time in the textile industry but have only recently been applied to the metal cleaning industry. E. T. CANDEE.

Influence of Bath Concentration on Chromium Hardness. R. J. PIERSOL, *Metal Cleaning & Finishing*, Vol. 7, No. 2, Feb. 1935, p. 73-76.—The hardness of the deposits was determined by finding the time to polish through 1 mil of plate. Solutions at 115° F., Sulphate ratio of 100-1 and trivalent chromium at its equilibrium concentration were run at various current densities and chromic acid concentration from 110-380 g/l. The solution containing 250 g/l. chromic acid run at 1.2 mils chromium per hour was most satisfactory. Higher concentration of chromic acid gave a softer plate. Lower concentrations gave a harder plate but range at which it could be obtained was narrower. E. T. CANDEE.

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Education *for the* Electroplater

C. B. F. YOUNG, PhD
Instructor, Chemical Engineering Department, Columbia University
Technical Director, U. S. Research Corporation

DURING the last ten or fifteen years there has been a very definite trend to applying scientific principles to electrodeposition. Before this period, the art of electroplating metals was accomplished by "rule of thumb" methods. Each plater had a formula for plating a certain metal which was guarded very carefully. If a solution did not work properly, the plater added a few compounds gathered at random and if this did not cure all the ills, the bath was discarded. Due to the small baths, this could be accomplished without a very great loss, but present day conditions do not premit this. Tanks of several hundred gallon capacities are very expensive. When such tanks are not working properly it is up to the electroplater to correct the faults. It is impossible to discard these solutions whenever trouble occurs. Therefore the electroplater should know the fundamental principles of electrolysis so that he will be able to correct the many faults which occur when an electroplating bath is used.

The question what to study and where to study arises in the mind of the electroplater. In the following paragraphs an attempt will be made to answer these questions in a clear and concise manner.

In order to meet the problems which arise in electroplating, one should not study electrodeposition alone. It is most essential that the elements of chemistry be understood, but it is not necessary to master a complete course in this science, only the underlying principles. For instance, the student should be able to name the common elements, give their approximate molecular weights, write and balance chemical equations, and work chemical problems involving direct and inverse proportions. Such a course can be obtained from high school chemistry,

first year college chemistry, or the numerous evening courses offered by the Universities and Technical schools.

The theory of electricity should be understood. The electroplater should be able to apply Ohm's law and to know its true meanings. He should also understand the theory of the dynamo and its auxiliary equipment. Such material can be obtained from a high school physics course or its equivalent.

After the electroplater has such a background, he is prepared to study electrodeposition from a scientific viewpoint. It is possible to study at home the theory underlying the deposition of metals, alloys, etc., but for the best results the student should obtain a practical laboratory course. Such a course should contain experiments on Faraday's laws, electrode potentials, current efficiencies, effect of temperature on deposits, thickness of deposits, current density studies, hydrogen ion concentration, polarization, throwing power, brightners, corrosion tests and analyses of plating solutions. In order that the student will not be lost while in the laboratory a short lecture should precede each laboratory period. During this time the instructor should review all the latest theories of electrodeposition and clarify any erroneous information which the students have obtained.

In such a course, the students should write a laboratory report in which all observations in the laboratory should be noted. The laboratory manual should be written to that the student would have to consult the latest standard text books, periodicals and technical papers which are published in this field. If such a course is pursued by a serious minded student, the results will become apparent in a short time.

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Unfortunately, such a laboratory and lecture course is not available to all students. At the present time (as far as the author knows), there is only one such complete course offered directly to the men in the plating field and that is being given at Columbia University, New York City, by the writer.

It has been suggested that such a course be offered by correspondence. This will be all right for a theoretical consideration but the laboratory work would be lacking and this is the most important part of such a course.

If the electroplater finds that it is impossible to obtain such a laboratory course as is mentioned above, he can better his status by studying over the latest text books on the electrodeposition of metals, reading the latest periodicals on electroplating and electrochemistry. An effort should be made to obtain the experience from such a laboratory course even if the electroplater has to work out his own experiments at the plating plant.

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Principles of Chemistry

For ELECTROPLATERS

DR. WILLIAM BLUM

LESSON IV
Chemical Equations

1—*Principles Involved.*

(a) A chemical equation is a mathematical statement of a chemical change or chemical reaction.

(b) The equation includes the formulas of all substances entering into the change, and all substances formed in the change.

(c) The equation indicates the number of atoms and molecules of each substance used and formed in the reaction.

(d) The total number of atoms of each element, and hence the total weight of each element, must be equal on the two sides of the equation.

(e) From the number of molecules (or atoms) used or formed, the proportions by weight of each substance involved may be calculated.

Example—When carbon burns in (an excess of) air, carbon dioxide is formed. This reaction is represented by the following equation.

$$C+O_2=CO_2$$

This equation may be read as follows: "One atom of carbon combines with one molecule (or two atoms) of oxygen to form one molecule of carbon dioxide."

The proportions by weight may be calculated by inserting the appropriate atomic weights (Lesson III).

$$\begin{aligned} C+ \quad & O_2 \quad = \quad CO_2 \\ 12+(2 \times 16) &= 12+(2 \times 16) \\ 12+ \quad & 32 \quad = \quad 44 \end{aligned}$$

Therefore 12 parts by weight of carbon combine with 32 parts of oxygen to form 44 parts of carbon dioxide.

2— *Use of Equations for Calculations.*

As the equation states the proportions by weight involved in that reaction, the quantity of any substance equivalent to a known weight of another substance may be calculated by simple proportion.

Examples—

1. (a) Assuming coal to be pure carbon, what weight of oxygen will be required to burn a ton (2240 lbs.) of coal?

Formula of substance given	:	Formula of substance required	: :	Weight of substance given	:	Weight of substance required
C	:	O_2	: :	2240	:	x
12	:	32	: :	2240	:	x

$$x = \frac{32 \times 2240}{12} = 5973 \text{ lbs.}$$

(b) How much carbon dioxide will be produced from one ton of carbon?

C	:	CO_2				
12	:	44	: :	2240	:	x

$$x = \frac{44 \times 2240}{12} = 8213 \text{ lbs.}$$

Caution: Always check your proportion and result by "common sense" methods. For example the equation shows that 12 parts of carbon require 32 parts of oxygen, or about 2.5 times as much. The result in (a) of 5973 lbs. evidently agrees approximately with this. If, however, a mistake had been made and the proportion had been reversed to 32 : 12 : : 2240 : x, the result obtained, 840 lbs. oxygen, would obviously be wrong, as this weight of oxygen would be less than that of the carbon.

2. Silver nitrate reacts with sodium cyanide to form silver cyanide and sodium nitrate according to the following equation:

$$AgNO_3 + NaCN = AgCN + NaNO_3$$
$$108+14+(3 \times 16)+23+12+14 = 108+12+14+23+14+(3 \times 16)$$
$$170 + 49 = 134 + 85$$

(a) How much silver nitrate will be required to prepare 100 gallons of a solution containing 4 troy oz/gal of silver cyanide?

given	:	required	: :	given	:	required
Silver cyanide	:	Silver nitrate	: :	400	:	x
AgCN	:	$AgNO_3$	: :	400	:	x
134	:	170	: :	400	:	x

$$x = \frac{170 \times 400}{134} = 507 \text{ troy ounces of silver nitrate}$$

(*NOTE*—One troy ounce=1.1 avoir. oz. As silver nitrate is usually sold in avoir. oz., it will be necessary to purchase

$$1.1 \times 507 = 558 \text{ avoir. oz.}$$

$$\frac{558}{16} \quad 35 \text{ lbs. of silver nitrate)}$$

(b) If it requires just as much sodium cyanide to redissolve the silver cyanide as to precipitate it, how much sodium cyanide will be required to precipitate and dissolve the silver cyanide required for this bath?

given	:	required	: :	given	:	required
Silver cyanide	:	Total sodium cyanide	: :	400	:	x
AgCN	:	2 NaCN	: :	400	:	x
134	:	2 x 49	: :	400	:	x
134	:	98	: :	400	:	x

$$x = \frac{98 \times 400}{134} = 292 \text{ troy oz. sodium cyanide}$$

$$292 \times 1.1 = 321 \text{ avoir. oz.}$$

$$\frac{321}{16} = 20 \text{ lbs. sodium cyanide}$$

Problems

1—How much sodium cyanide (NaCN) will be required to dissolve 25 lbs. of copper cyanide (CuCN) in accordance with the following equation?

$$CuCN + 2NaCN = Na_2Cu(CN)_3$$

2—If you have 100 gallons of an acid pickel containing 8 avoir. oz/gal of sulphuric acid (H_2SO_4), how much iron would it dissolve before the free sulphuric acid dropped to 4 oz/gal? Equation—

$$Fe + H_2SO_4 = FeSO_4 + H_2$$

3—Suppose a 100 gallon chromic acid bath was found to contain 0.5 oz/gal of sulphuric acid (H_2SO_4) and it was desired to reduce this to 0.3 oz/gal by adding barium carbonate ($BaCO_3$). How much barium carbonate is required? Equation—

$$H_2SO_4 + BaCO_3 = BaSO_4 + H_2O + CO_2$$

Business and Social News

BRANCH NEWS

Educational Activities

AMERICAN ELECTRO-PLATERS' SOCIETY

CHICAGO BRANCH

The regular monthly meeting of Chicago Branch was held March 9, at the Atlantic Hotel, President E. G. Stenberg presiding and all other officers present.

Mr. E. Sward was transferred from the Chicago Branch to Hartford, Conn. Branch.

Mr. J. E. Archer was elected an associate member, Mr. L. Van Steen and Mr. C. Kelly were elected active members.

A new application was received from H. A. Haisman and a committee appointed on same.

It was decided to have our June meeting on June first instead of our regular date so that delegates and members that plan on going to the convention can attend our Booster meeting.

Mr. O. E. Servis the librarian found the following questions in the question box.

No. 1. What would be the best method to remove carbon smut from a heat treated steel surface or hot rolled steel? This question refers to an alkali cleaner.

Answer. Use two cleaners if possible one with straight direct current, and the second with reverse current, both caustic cleaners with a small amount of cyanide and use a warm rinse.

No. 2. How can parts be dried off after chrome plating so that they do not show chrome acid and water stains?

Answer. After chrome plating rinse in cold water then in a luke warm rinse with a small amount of soda, then rinse and dry.

No. 3. What factors cause evolution of chlorine gas from nickel solutions?

Answer. Insoluble anodes, also when using a lead lined tank the lead should be insulated as this causes evolution of chlorine gas.

No. 4. May anodic cleaning of brass be used and if so how long should the treatment be for?

Answer. Reverse current may be used in the cleaning of brass but treatment should not be very long.

No. 5. What is the practice for plating for long life of Zinc die castings?

Answer. A heavy deposit of copper and a heavy deposit of nickel.

No. 6. How can the percentage of cupric and cuprous ions in a cyanide copper be determined; what is the ideal percentage?

Answer. Can not be determined.

No. 7. On a frame of cold rolled steel, the corners of which are spot welded together, in a nickel solution gassing in these corners causes a streak which nickel buffs O.K. but lifts off when chrome plated. How can this be overcome?

Answer. Many suggestions offered, such as cleaning the steel before welding also dipping the frame in muriatic acid right from the cleaner, then rinse and return to the cleaner for a second cleaning.

No. 8. What is a good formula for hot copper solution?

Answer. 4 oz. copper cyanide, 4½ oz. sodium cyanide, caustic soda 1 oz., water 1 gal. Temp. about 110°. A very small amount of Hypo helps to give a bright deposit.

J. W. HANLON, *Sec.*

HARTFORD BRANCH

The Hartford Branch of the A. E.S. held their regular meeting on Monday evening, February 25, 1935, at the State Trade School, in Hartford, Conn.

The meeting was called to order at 8:30 P.M., with President St. Pierre in the Chair. Minutes of the previous meeting were read and accepted. One communication was read and placed on file. No bills were presented.

Mr. H. C. Duggan, of the Oakite Products Co., was speaker for the evening. He gave a very interesting talk on the Analysis and Control of Cleaning Solutions. His talk was enjoyed very much and in conclusion he was given a rising vote of thanks.

The meeting adjourned at 10:30 P.M. V. E. GRANT, *Sec.*

The Hartford Branch of the A.E.S. held its regular monthly meeting on Monday evening, March 25, 1935, at the Elk's Club, Bristol, Conn. The meeting was .called to order at 8:30 P.M. with President St. Pierre in the Chair. Minutes of the previous meeting were read and accepted. All communications were read and placed on file. One bill for our third quarter per capita tax, amounting to seventeen dollars and thirty-three cents ($17.33) was voted paid.

Mr. Promisel, Chemist for the International Silver Co., of Meriden, Conn., was speaker for the evening. He gave a very interesting as well as educational talk on "Recent Developments in the Electro-plating Industry." His talk covered many phases of the trade, some of the things covered in his lecture were developments in cleaning, plating and control of the various parts of our work.

In conclusion, Mr. Promisel was given a rising vote of thanks for his very fine talk.

The meeting was attended by eighteen members and adjourned at 10:30 P.M. V. E. GRANT, *Secy.*

ANDERSON BRANCH

The following is a record of our monthly meetings to date:—

November Meeting (*November* 3, 1934). Mr. George Hogaboom of the Hanson-Van Winkle-Munning Company opened the first fall meeting with his paper on "What's Under the Plate". The meeting was preceded by a dinner served at the Y. M. C. A. Mr. Hogaboom gave a very interesting and instructive talk and was well received as was indicated by the lively discussion following the talk. The meeting was adjourned by President Cole.

December Meeting (*December* 1, 1934). Encouraged by the excellent attendance at the November meeting it was decided to continue with the dinner meetings at the Y. M. C. A. Mr. Gustav Soderberg of the Udylite Corporation was the speaker of the evening. Mr. Soderberg gave us a very instructive talk on the respective merits of Cadmium plating as compared with Zinc both in regard to cost and as to the corrosion resistance of the two metals. Considerable discussion followed the talk and showed plainly the interest in the subject matter. President Cole adjourned the meeting.

January Meeting (*January* 14, 1935). A short business meeting was held at the Y. M. C. A. Matters of financial interest were discussed and voted on.

February Meeting (*February* 4, 1935). The policy of the dinner meetings at the Y. M. C. A. was continued. Mr. Oplinger of the DuPont deNemours Company delivered an excellent talk on Zinc Plating in which he discussed the relative costs and corrosion resistance of Zinc as compared to other

metals. Mr. Oplinger's talk was very well received and considerable discussion followed his talk. The meeting was adjourned by President Cole.

FRED W. CARL, *Sec.*

LOS ANGELES BRANCH

The Los Angeles Branch held its monthly meeting on February 4th instead of the usual second Wednesday date, in commemoration of the sixth anniversary of the founding of the Branch. This meeting was the best attended since the big second anniversary meeting in 1930. The interesting subjects on the program, and the way they were handled, more than justified the large attendance. The meeting lasted until almost midnight and there was not a dull moment in it.

President M. D. Rynkofs opened the meeting with a few remarks suitable to the occasion and then turned the meeting over to the vice-president, Bob Gripp, who acted as chairman for the evening.

The first subject was "Metal Cleaning" by P. A. Boeck of the Oakite Products Co. Mr. Boeck has long been recognized as an authority on metal cleaning and he covered the subject very thoroughly.

Mr. H. K. Burdick, N. R. A. code authority for this district gave a very interesting talk on the value of cooperation between manufacturers or shop owners, and their employees.

A very interesting talk was the one by Mr. Rynkofs on "The Value of Electro-Plating as a Means of Preserving Bodies after Death." He illustrated the talk with a bronze plated pig and explained that this same process could be applied to a human body. Incidentally the pig's name is Oscar. Frank Rushton wanted to know if it was named after Oscar Servis.

Messrs. Smidel, Rushton, and Rynkofs explained by means of diagrams the use of various racks and special tricks used in chromium plating. They demonstrated the fact that to be a good chromium plater a man must have considerable ingenuity.

A great deal of credit is due Mr. Rynkofs for the success of the meeting, for it was he who drew all the diagrams used, made one of the most interesting talks of the evening and headed the committee that arranged the whole affair. Also he furnished the beer and sandwiches at the committee meetings.

EARL COFFIN, *Sec.-Treas.*

BRIDGEPORT BRANCH

The regular monthly meeting of the Bridgeport Branch was held in The Chamber of Commerce Rooms in the Stratfield Hotel on Friday, March 1, at 8:30 P.M. There were twenty-nine members present. The minutes of the previous meeting were read and accepted. Ray O'Connor, Chairman of the Convention Committee reported that plans are nearing completion very successfully for the coming Convention. The Ladies' Committee, headed by Mrs. O'Connor, is meeting regularly.

Mr. Walter Rowe, of the North and Judd Co. of New Britain, was the guest speaker of the evening. He spoke on "Spotting Out on Brass Plated Articles". Walter Meyer will speak at the April open meeting on "Zinc and Die Casting Plating."

Paul Lalonde was elected as an associate member.

The raffle for the evening was donated by Joseph Sexton and won by Walter Rowe.

The meeting adjourned at 11 P.M.

WM. FLAHERTY.

MILWAUKEE BRANCH

The regular meeting of Milwaukee Branch A. E. S. was held at Lipp's Hall, N. 3rd and W. Highland Ave.,

March 14, 1935. The meeting was called to order by President Pat. Sheehan. Minutes of the last regular meeting were approved as read.

Mr. Anton Chlosta of 1634 N. 9th St., Sheboygan, Wis., had made application for membership in Milwaukee Branch as an active member. After a short business meeting, during which John Miszewski, Jr., was initiated as an active member, and given a welcoming hand by all members. The educational session was at the Republican Hotel. Here Mr. Robt. Tuttle of the Tuttle Chemical Co., gave us a clear, and decisive demonstration of plating zinc and zinc base materials with nickel. A good many of us have heard of "Zialite" but here was an actual showing, and the questions asked, and the interest taken in the demonstration clearly indicated that here was an answer to many platers prayers. We all agreed that this kind of instruction was enlightening and that future meetings could be of great value if more such meetings were held.

All thanks to Mr. Tuttle and Mr. Hay for this demonstration and also for the jolly gathering which ended the evening entertainment.

FRANK J. MARX

WATERBURY BRANCH

Regular business was dispensed with at the March meeting of Waterbury Branch, A. E. S., in order to allow the members and many visitors to listen to and discuss with George B. Hogaboom, the merits of his talk entitled "What Is Under the Plate," and which someone else has appropriately called "The Platers' Perfect Alibi." The meeting was held Friday evening, March 8th, at the Chase Auditorium, Grand Street and was presided over by the President, Tennant Elwin. The speaker who is well known in Waterbury, having labored here some years ago, and who also organized the local Branch, was the means of drawing an appreciative audience of listeners. Ellsworth Candee assisted the speaker in looking after the lantern slides, which accompanied the talk. After hearing the remarks and viewing the evidence as produced by the slides, the thought occurs that often in the past the plater has been a much maligned man; but now, with the evidence obtainable, conditions will differ; "he'll tell 'em." Many questions were asked and answered; after which, a rising vote of thanks was extended to the speaker.

Thirty-five men were thrown out of employment when fire of undetermined origin destroyed the H. C. Baum Electro-plating Co., of Plainville, recently. Low water pressure and a high wind made it difficult for firemen to prevent spread of the flames, which caused an estimated loss of $20,000.

W. F. GUILFOILE, *Secy.*

DETROIT BRANCH

A regular meeting of the American Electro-Platers' Society, Detroit Branch was held on Friday evening, March 1st, at 8:00 P.M., at Hotel Statler. Our President, Col. Hansjosten, not being present, Mr. McCord took the Chair. The meeting had scarcely opened when Col. Hansjosten arrived and Mr. McCord turned the meeting over to him.

Minutes of previous meeting were read and approved.

There were four applications for membership as follows:

Mr. George Lodge, 2100 Hubbard St., Detroit, Mich.; Mr. Roy Wayne Rapp, R. F. D. No. 1., Wyandotte, Mich.; Mr. Russell Raab, 3204 Helen

Ave., Detroit, Mich.; Mr. Frank J. Gach, 6628 Willette, Detroit, Mich.

Col. Hansjosten read a letter from the Supreme Society, asking Detroit Branch to take a vote on the Resolution passed by the Convention held in Detroit in June, 1934. This was a resolution for an amendment to the Constitution regarding taking in Assistant Foremen as Active Members to the Society. The Detroit Branch took a vote to support this Amendment.

Another resolution, moved, supported and carried was that the Detroit Branch go on record as being opposed to the suggestion for an Amendment to the Constitution creating firm memberships.

The Speaker of the evening was then introduced. Mr. James Higgins, Chemist of the Packard Motor Car Co., spoke on the subject of "Zinc Plating." The paper was very interesting, educational and very well read, and created quite a lot of discussion. His paper will be published in the near future in our MONTHLY REVIEW.

Under the head of New Business, it was decided that at our next regular meeting, we will have refreshments and a Committee was appointed to take care of this. The following Committee was appointed: Mr. George Kutzen, Mr. Geo. Nankervis. Mr. C. L. Southwick, Mr. L. R. Eastman, Mr. Charles Beaubien.

The meeting adjourned at 9:30 P.M.

T. C. EICHSTAEDT, *Sec.-Treas.*

ROCHESTER BRANCH

The Rochester Branch held its regular monthly meeting at the Seneca Hotel on Friday night March 15th. Meeting called to order by Pres. Kohlmeier. Minutes of previous meeting read and approved. Committee in charge of bowling party reported everything ready for a grand old time. Mr. R. L. Del Rosso and Mr. C. H. Brunett were elected members. The President then presented Mr. Del Rosso with an A. E. S. pin which formerly belonged to Mr. Chas. Dunavan who had to resign because of failing health at which time he donated the pin and requested that it be presented to the first new member. We had as our guest Mr. Wm. Chase of the Agate Lacquer Co. who favored us with a few remarks after which the meeting adjourned.

CLEVELAND BRANCH

The regular monthly meeting of the Cleveland Branch was held on March 2nd 1935; the meeting was called to order by our President Mr. W. D. Scott, at 8:15 P.M.

The minutes of the February meeting were approved as read. No elections or committee reports. The bills were ordered paid. A letter from our Supreme President was ordered to be read again at the next meeting. A card of acknowledgment of our sympathies was read from Mrs. Charles Smith and family, who lost their husband and father on February 8th, 1935. We are sorry to see the passing of this charter member who was very loyal in the support of the activities of the American Electro-Platers' Society. The meeting was then turned over to our librarian, Mr. Thompson, who introduced Mr. Pearsall of the Bruce Products Corporation, who spoke to us about the different cloths that go into the making of buffs, their construction and manufacture. He also showed a polishing wheel of their idea and design which looked as though it would eliminate some of the troubles confronted in our polishing departments. He further pointed out that most of us do not run our lathes at the proper R.P.M. After some dis-

cussion the members gave a rising vote of thanks. There being no further business the meeting adjourned.

W. E. O'BERG, *Sec.-Treas.*

SPRINGFIELD BRANCH

The Springfield Branch held its regular meeting at the T. J. Murray Co. Office on Monday evening, March 25, at 8 P.M. Mr. W. Seidel of the National Blank Book Co., Holyoke, the newly elected President, called the meeting to order.

Business of routine importance was transacted.

Mr. P. W. Prouty, Materials and Processes Engineer, Westinghouse Electric and Manufacturing Co., was introduced by the President as the speaker of the evening. Mr. Prouty's subject, "Lacquer and Enamel Finishing of Steel used in Electric Refrigerator Cabinets," was extremely interesting and gave his audience a definite idea of the research necessary to produce a satisfactory finish that will stand up under climatic conditions in different parts of the country. Over a hundred plates were shown by the speaker, each one telling its own story regarding color, adhesion, ductility, etc.

The speaker was given a rising vote of thanks for his splendid talk.

A number of good speakers are listed for the future meetings of the Branch.

ATTENTION MEMBERS

There may be some individual in your organization to whom you feel it would be to your interest to have a complete Convention Program mailed.

This copy will be mailed, in addition to your own copy, about May 1st. Send such names, plainly printed, at once to George G. Knecht, 132 West Elm Street, New Haven, Conn.

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This man must be able to maintain his solutions and work generally in the shop. Communicate at once with

MR. E. STEEN THOMPSON,
Supreme Secretary,
905 W. 10th St.,
Erie, Penna.

PARTIAL LIST OF EXHIBITORS
A. E. S. Bridgeport Convention

Udylite Company
Chandeysson Electric Company
Egyptian Lacquer Company
Rex Products & Mfg. Company
Hanson Van Winkle & Munning Company
Contract Plating Company
J. B. Ford Sales Company
F. B. Stevens, Incorporated
Zapon Company
Iron Age
Pyrene Mfg. Company
Oakite Products, Incorporated
Chromium Corporation of America
Lea Manufacturing Company
Lasalco, Incorporated
Seymour Manufacturing Company
Apothecaries Hall Company
Grasselli Chemical Company
Maas & Waldstein
N. Ransohoff, Incorporated
Norton Company
Carborundum Conpany
Tuttle Chemical Company
Matchless Metal Polish Company
MacDermid, Incorporated
J. C. Miller Company
U. S. Galvanizing & Plating Equipment Corporation
G. S. Blakeslee & Company
Atlas Powder Company
Yankee Products
MacFarland Mfg. Company
Chromium Process Company
Bullard Company

REPORT ON EXHIBITION

The above is a partial list of exhibitors. Please bear in mind that additional reservations have been made by concerns we know will exhibit but until the contracts are definitely signed, we do not wish to state they are in the "show".

The exhibition is being held in a building entirely apart from the hotel and one very well adapted to exhibitions of this kind, being about five minutes ride by automobile.

During the Exhibition you will see de-greasing machines in operation. There will also be a new filtering unit in operation. Another exhibitor will operate the latest and newest type tumbling mill. Several concerns are arranging to demonstrate new methods of plating through the use of small plating units in actual operation. Another exhibitor will demonstrate the latest method of galvanizing. Still another exhibitor will demonstrate a new method of removing scale, oxide and other elements from parts prior to plating.

It will be to the mutual advantage of all concerned for the management of all eastern industries to make suitable arrangements for the key men of their organizations to visit the Exhibition and learn new ways and methods to produce better work and to see the latest equipment with every modern improvement.

R. T. PHIPPS,
Manager of Exposition.

Zinc Plating

Read at Detroit Branch Meeting

By JAMES HIGGINS

Packard Motor Car Co.

As you all know, there is nothing new about the fact that zinc can be successfully electro-deposited. The metal forms double salts and can be plated from practically every type bath used for any other metal. However, zinc plated parts are not as a rule used for *decorative* purposes, as they do not have the pleasing appearance of other metals plated over the same base metal. Certainly cadmium, plated over steel, has a nicer color and much more lustre than any zinc I have been able to deposit. However, I believe zinc-plated parts have a very definite field in the automotive and other industries, and I would like to tell you of our experiences in zinc plating.

We began plating zinc experimentally in our laboratories about five years ago and first tried using the acid type bath which was made up as follows:

Zinc Sulphate	40.0	ounces per gallon
Amon. Chloride	4.0	" " "
Sodium Acetate	2.0	" " "
Licorice	0.15	" " "

Some difficulties were experienced with this type bath, particularly with the throwing power. Current densities, temperatures, composition of the bath, etc., were varied, but we were unable to get uniform results, and as our work was purely experimental, we decided to do some work with the cyanide bath and made one up of the following composition:

Zinc (Metal)	5.0	ounces per gallon
Sodium Cyanide (Total)	17.5—18.5	" " "
Sodium Hydroxide (Total Alk.)	5.0	" " "
Corn Syrup	1	per cent
Anodes	99+	per cent zinc

The above bath gave a mixture of the double cyanide Salt ($Zn(Cn)_2$+2 NaCn equals $Na_2 Zn(Cn)_2$; and Sodium Zincate:) 2 $Zn(Cn)_2$ + 4 NaOH equals $Na_2 Zn(Cn)_4$+Na_2ZNO_2+2 H2O.

This bath was operated, varying the C.D. from 5 to 25 amperes per square foot, and the temperature from 100° F. to 130° F. The results obtained were very encouraging as the deposit was quite bright and gave excellent salt-spray resistance. The brightest and best looking plate was deposited at 15 amperes per square foot for 15 minutes at 110° F.

It was decided to put the above type bath in production and our production experience checked our laboratory work for some time and we were getting a fairly acceptable looking plate. However, within a month or so, the deposit began to get darker and *continued* getting darker. This was particularly noticeable on poorly finished steel parts and on cast iron. More Karo Syrup was added and this brightened the deposit temporarily. Mercury, as the oxide, was also added, and this helped, but it again was of short duration.

Fortunately there were no complaints on the appearance of the plate, and it was probably more a matter of pride than anything else which led us to keep trying to improve the appearance of the deposit. This bath, by the way, was equipped with a moving cathode.

The bath, as outlined, was used for about 3 years with perfectly satisfactory results.

About a year or so ago, an anode was brought on the market containing ½% Hg.—2% Al, and the balance pure zinc. We were very much interested in this anode for the reason that considerable work was done in the laboratory with Duo Zinc baths a few years ago. This type bath gave a beautiful deposit and we felt it was probably due to the Hg in anodes more than anything else.

The new Hg—Al anode was purchased and has been in use for the past year or so.

A very noticeable improvement in the appearance of the plate was obtained with this type anode and some samples of our ordinary production plating are here which will give you an idea of what you can expect in production zinc plating.

Membership Drive Barometer

Branch	Elected	Reinstated
Detroit	12	2
Chicago	11	1
Balto-Washington	7	
Hartford	4	2
Philadelphia	4	
Milwaukee	3	
Bridgeport	3	
Toronto	2	2
St. Louis	2	
Rochester	2	
Boston	1	
Dayton	1	
Los Angeles	1	1
Providence	1	
Montreal	1	
Anderson	1	
Toledo	1	
Cincinnati		
Cleveland		
Grand Rapids		
Newark		
New York		
Pittsburgh		
San Francisco		
Waterbury		

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